Use of Geochemical Tracers to Elucidate Life History Trajectories of Gray Snapper within South Florida's Marine Ecosystems

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ABSTRACT

The elemental composition of otoliths extracted from juvenile gray snapper (*Lutjanus griseus*) collected in and around Florida Bay were examined using solution based Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) in order to determine the existence of a unique "Florida Bay Signature". Our ultimate goal is to employ multivariate pattern matching techniques comparing the juvenile portion of adult otoliths from the reef tract to our "Bay signature" in order to assess the proportion of adults on the reef that used the Bay as a nursery habitat. Here we describe a "Florida Bay signature" primarily defined by the rare earth components of the elemental suite examined. This "Bay signature" allows high-resolution spatial separation of collection sites, on the order of 10 km, with additional, significant variation attributed to habitat type.

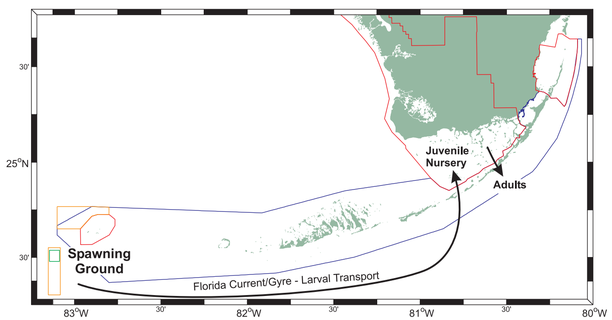
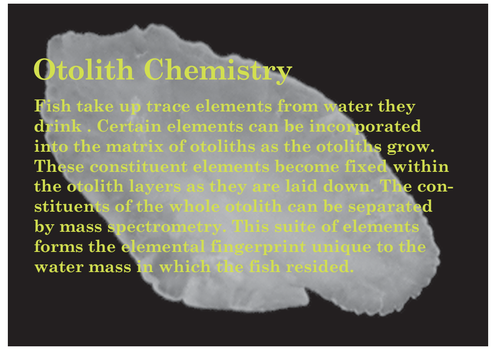


Figure 1. Proposed life history trajectory of Gray Snapper in South Florida Marine Ecosystem.

RESEARCH GOALS

It is our intent to map the source of recruits in the Sanctuary Preservation Areas (SPA) of the Florida Keys and the Dry Tortugas Sanctuary using recent technological developments that allow us to detect trace elemental "fingerprinting" of fish otoliths. Multivariate pattern matching techniques allow separation of fish stocks exposed to different environments. Commercially important snapper and grouper communities are believed to recruit to the reef within the FKNMS from other areas, such as seagrass and mangrove habitats of Florida Bay, where they are believed to spend their juvenile phase before migrating to the coral reefs as young adults. The source of recruits is of particular importance given the recent efforts to restore Florida Bay and the establishment of SPA's and the Tortugas Ecological Reserve. These protected coral reef areas need an established and protected source of recruits if they are to function as a reef fish sanctuary. The ability to reconstruct the environmental history of individual fish is a significant advance and offers a new tool to fisheries management. We intend to use these properties to determine "coral reef" and "Florida Bay" signatures by collecting settled juveniles from the estuaries. Once we have established this signature, we will compare it to adult fish taken from or adjacent to the coral reef SPA's and the reefs of the Tortugas Ecological Preserve. From the comparison of trace element signatures we should be able to determine the percentage of adults found on the coral reefs that used Florida Bay as a nursery habitat.



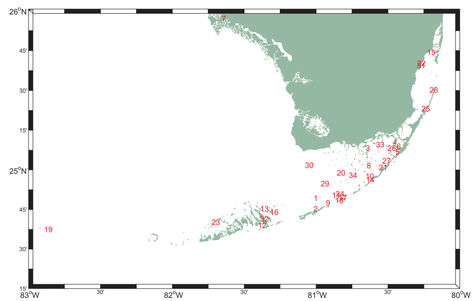


Figure 2. Map of the study area indicating the 34 collection sites.

METHODS

The otoliths of 321 juvenile snappers were collected in 2001-02 from 34 sites in Florida Bay, Biscayne Bay, the Dry Tortugas, and the Ten Thousand Islands. All dissection, cleaning and drying of the otoliths was performed in a class-100 cleanroom environment using acid washed glass instruments. The samples were processed in a double focusing sector field Inductively Coupled Plasma Mass Spectrometer (Finnigan MAT Element 2 ICP-MS) housed in the Laboratory for Isotope and Trace Element Research (LITER) at Old Dominion University.

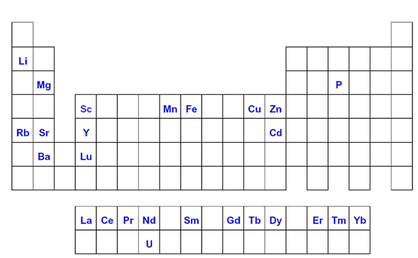


Figure 3. Periodic table of the 26 elements targeted by the ICP-MS analysis.

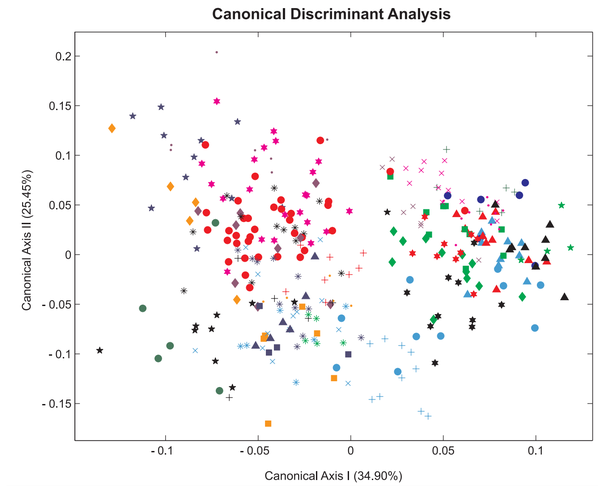


Figure 4. Canonical Discriminant Analysis plot depicting microchemical signatures based on 26 elements for 321 snapper otoliths collected from 34 sites. Permutation-based global signficance level was p = 0.0002 for 5000 iterations.

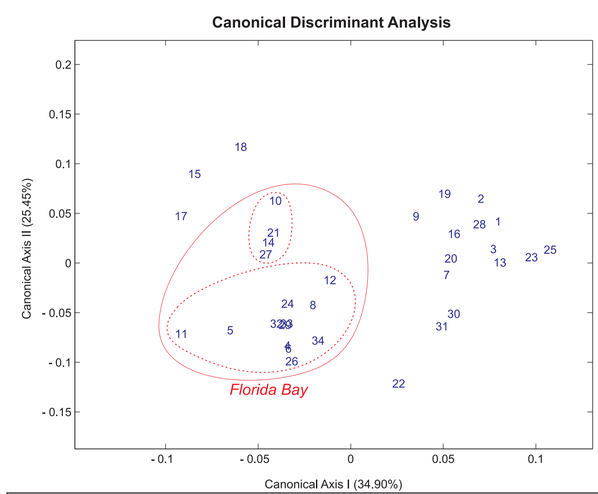


Figure 5. Canonical Discriminant Analysis plot depicting only group centroids for each of the 34 collection sites. Red ellipses enclose sites in which differences in microchemical constituents are nonsignificant at the 0.05 level (permutation-based iterations = 5000).

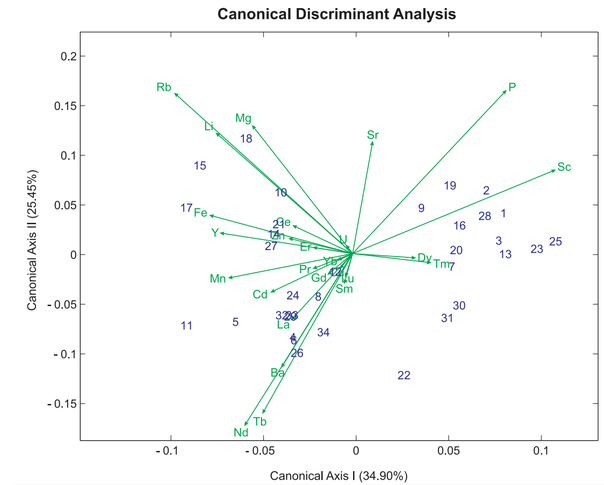


Figure 6. Canonical Discriminant Analysis vector correlation for each of the 26 elements analyzed. Length of vectors indicates the relative contribution of each element to the pattern of site separation in terms of chemical composition. Direction of vectors indicates the direction of increase of each element across sample sites (i.e., gradient).

CONCLUSIONS

We have succeeded in identifying a unique "Florida Bay" trace chemical signature based on the relative proportions of 26 elements from 321 fish otoliths collected across 34 sampling sites. The elemental composition of the otoliths from fish collected from sites within Florida Bay did not vary significantly (Figure 5); however, the trace chemical composition was significantly different from those collection sites occurring outside of Florida Bay (i.e., Biscayne Bay, Lower Florida Keys, Dry Tortugas, Ten Thousand Islands). The 5 most important elements responsible for the patterns observed were Rb, P, Sc, Nd, and Tb--the last 2 being members of the Rare Earths (Figure 6). The results from our analysis allowed high-resolution spatial separation of collection sites, on the order of 10 km. Additionally it appears that a substantial amount of the variation can be attributed to habitat type (e.g., mangrove vs. seagrass vs. hard-bottom).

We will now begin to analyze otoliths from fish collected on the offshore reefs for this signature, indicating their use of the Bay as a juvenile nursery ground. By using this technology we hope to establish both the contribution Florida Bay makes to the reef population in acting as a nursery ground for juvenile snappers, and to delineate the life history of these fishes. We wish to document the route taken from spawning to adulthood and the importance of various regions such as the Dry Tortugas and Florida Bay at various stages.